

Multi-Scale Hydrometeorological Modeling, Land Data Assimilation and Parameter Estimation with the Land Information System

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The Land Information System (LIS; <http://lis.gsfc.nasa.gov>; Kumar et al., 2006; Peters-Lidard et al., 2007) is a flexible land surface modeling framework that has been developed with the goal of integrating satellite- and ground-based observational data products and advanced land surface modeling techniques to produce optimal fields of land surface states and fluxes. As such, LIS represents a step towards the next generation land component of an integrated Earth system model. In recognition of LIS object-oriented software design, use and impact in the land surface and hydrometeorological modeling community, the LIS software was selected as a co-winner of NASA's 2005 Software of the Year award. LIS facilitates the integration of observations from Earth-observing systems and predictions and forecasts from Earth System and Earth science models into the decision-making processes of partnering agency and national organizations. Due to its flexible software design, LIS can serve both as a Problem Solving Environment (PSE) for hydrologic research to enable accurate global water and energy cycle predictions, and as a Decision Support System (DSS) to generate useful information for application areas including disaster management, water resources management, agricultural management, numerical weather prediction, air quality and military mobility assessment.

LIS has evolved from two earlier efforts – North American Land Data Assimilation System (NLDAS; Mitchell et al. 2004) and Global Land Data Assimilation System (GLDAS; Rodell et al. 2004) that focused primarily on improving numerical weather prediction skills by improving the characterization of the land surface conditions. Both of GLDAS and NLDAS now use specific configurations of the LIS software in their current implementations. In addition, LIS was recently transitioned into operations at the US Air Force Weather Agency (AFWA) to ultimately replace their Agricultural Meteorology (AGRMET) system, and is also used routinely by NOAA's National Centers for Environmental Prediction (NCEP)/Environmental Modeling Center (EMC) for their land data assimilation systems to support weather and climate modeling. LIS not only consolidates the capabilities of these two systems, but also enables a much larger variety of configurations with respect to horizontal spatial resolution, input datasets and choice of land surface model through “plugins”. As described in Kumar et al., 2007, and demonstrated in Case et al., 2008, and Santanello et al., 2009, LIS has been coupled to the Weather Research and Forecasting (WRF) model to support studies of land-atmosphere coupling by enabling ensembles of land surface states to be tested against multiple representations of the atmospheric boundary layer. LIS has also been demonstrated for parameter estimation as described in Peters-Lidard et al. (2008) and Santanello et al. (2007), who showed that the use of sequential remotely sensed soil moisture products can be used to derive soil hydraulic and texture properties given a sufficient dynamic range in the soil moisture retrievals and accurate precipitation inputs. LIS has also recently been demonstrated for multi-model data assimilation (Kumar et al., 2008) using an Ensemble Kalman Filter for sequential assimilation of soil moisture, snow, and temperature. Ongoing work has demonstrated the value of bias correction as part of the filter, and also that of joint calibration and assimilation. Examples and case studies demonstrating the capabilities and impacts of LIS for hydrometeorological modeling, assimilation and parameter estimation will be presented as advancements towards the next generation of integrated observation and modeling systems.